GEOFON – Seismological Infrastructures, Global Seismic Monitoring and Tsunami Warning

Winfried Hanka
GFZ German Research Centre for Geosciences
Potsdam, Germany

SCUG3 Meeting, Potsdam,September 21, 2010

GFZ
Helmholtz-Zentrum
POTSDAM

GEOFON – Cooperation is the Key!

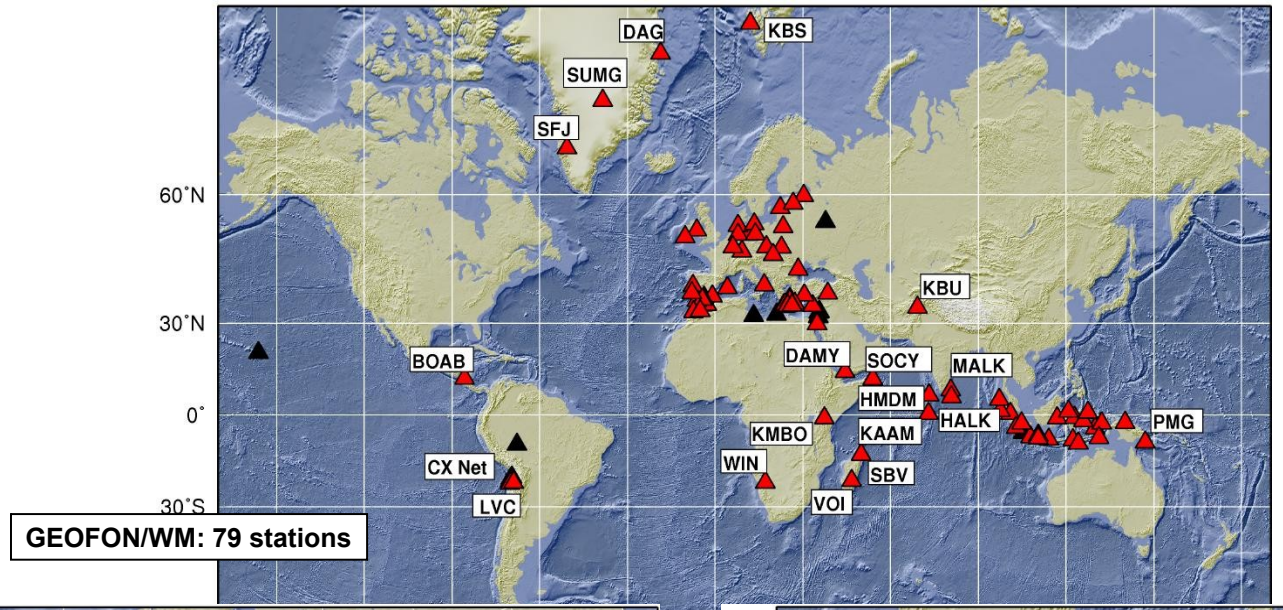
GEOFON tries

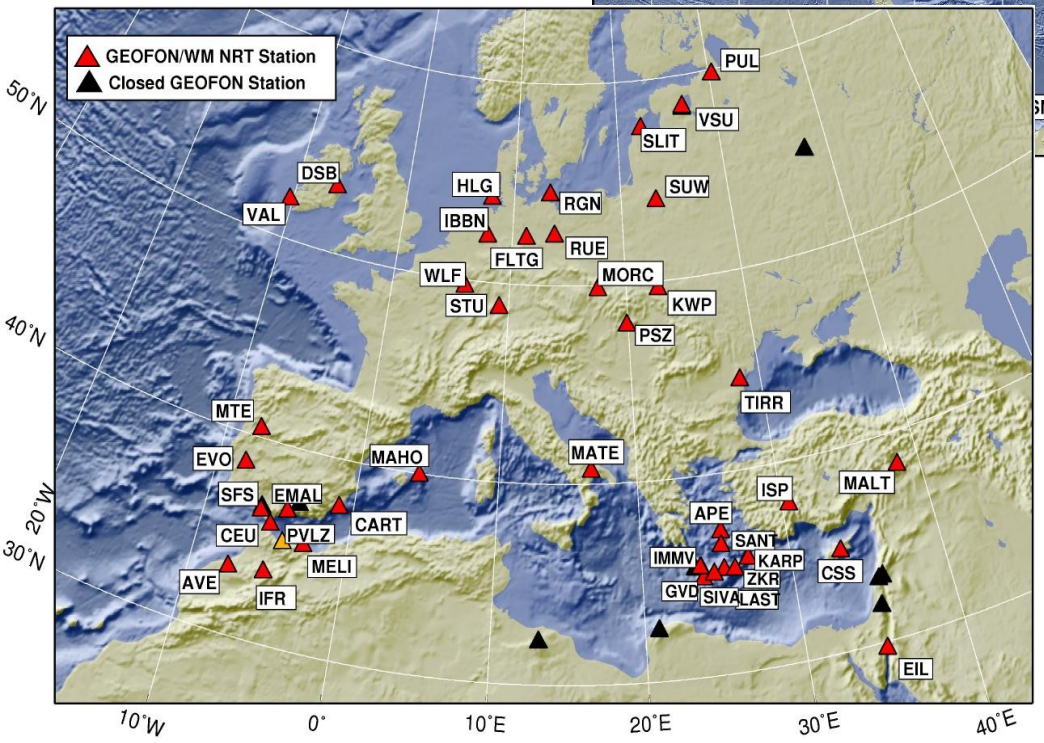
- **to promote international broadband seismology in Europa and worldwide and**
- **to obtain maximum impact from minimum resources by intensive cooperation on all levels.**

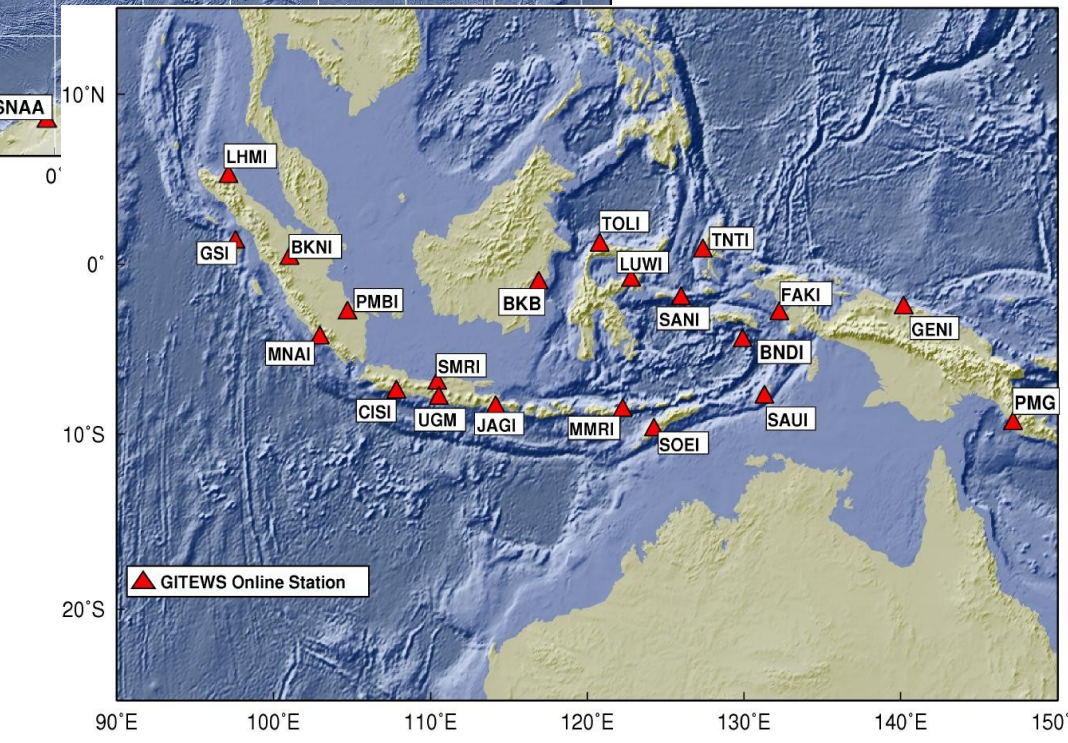
It

- **deploys permanent stations (~80), primarily as nuclei for adequate national networks (> 400 stations)**
- **develops software (SeisComP) for cooperative distributed**
  - **real-time data collection (SeedLink => MEREDIAN)**
  - **data archival & distribution (ArcLink => NERIES)**
  - **real-time data processing (SC3 => early warning projects)**
- **provides several services to the community**
  - **technical support on several levels**
  - **backup data archival (GEVN, EIDA)**
  - **earthquake information (EMSC, TWS)**

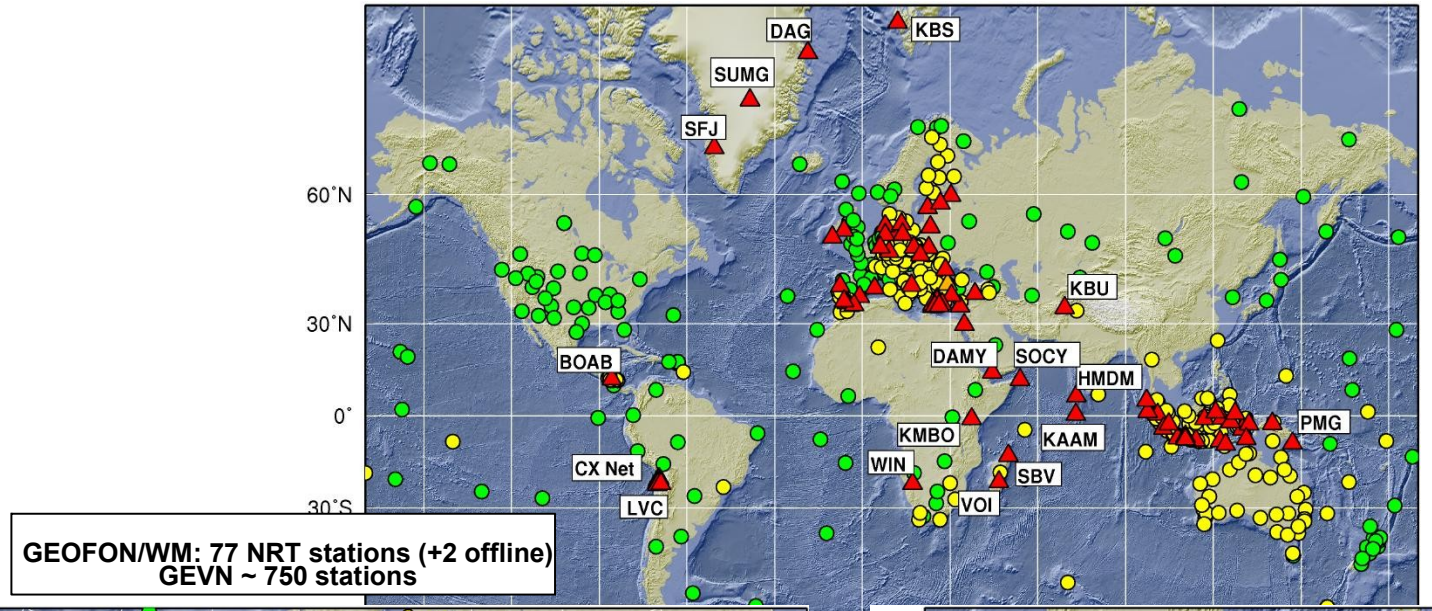
GEOFON Permanent Seismic Network

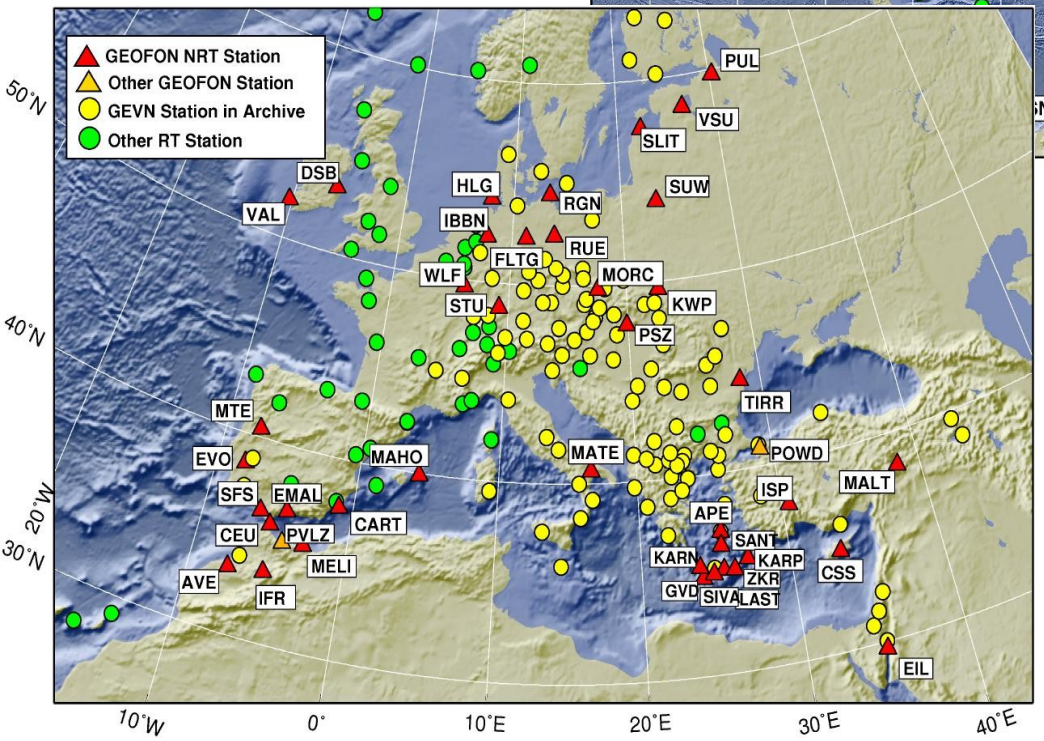


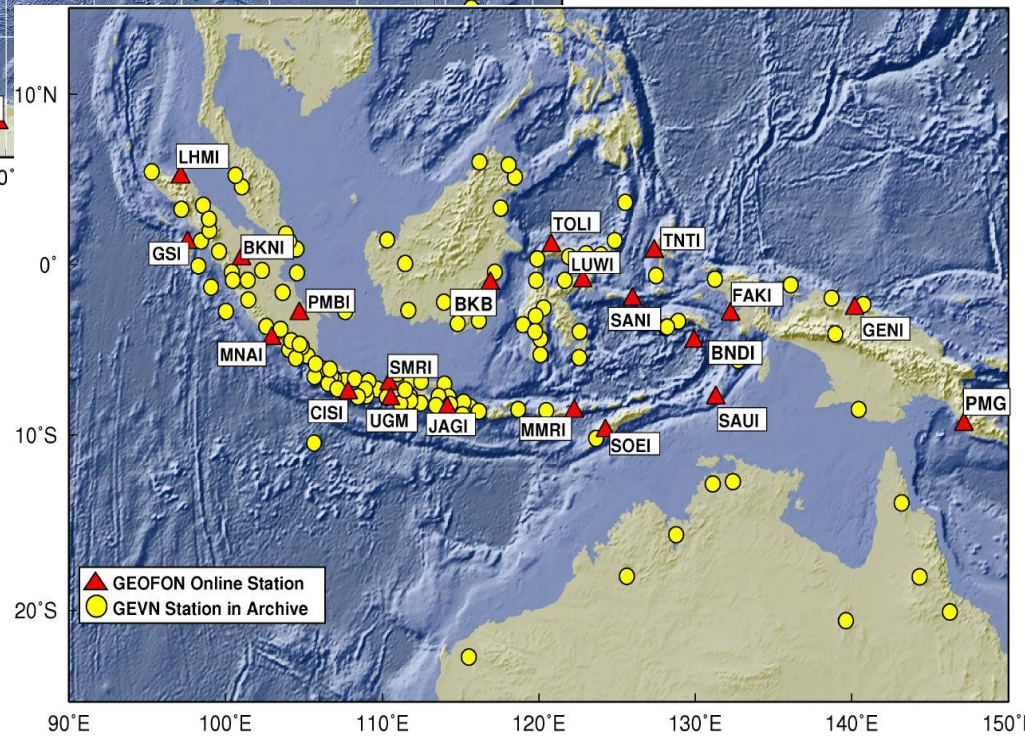




GEOFON Extended Virtual Network







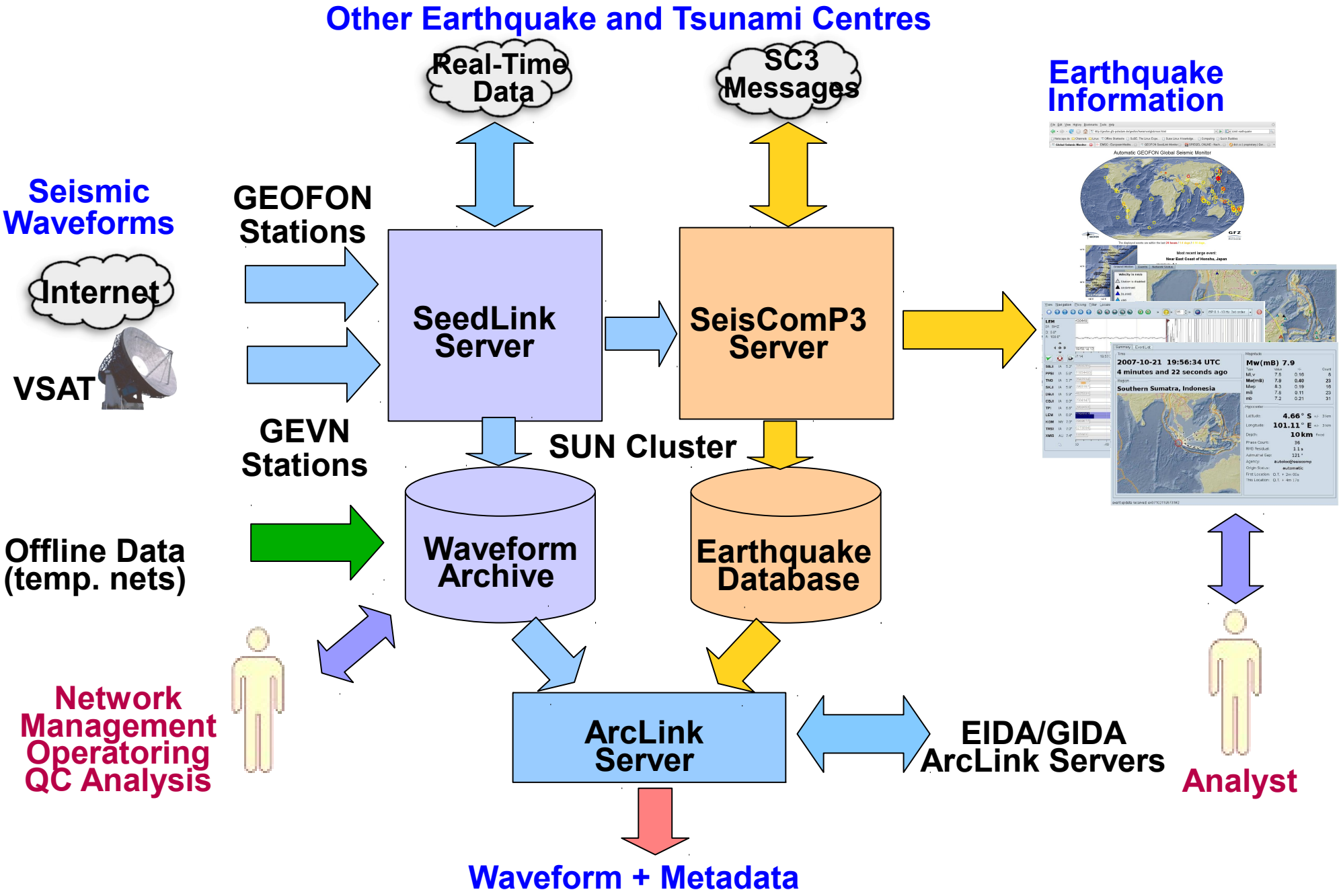
Why Global Earthquake Monitoring is a Task for GEOFON?

Trigger: The Boumerdes (Algeria) Mw=6.8 earthquake of May 25, 2003

Insufficient public informations!
No first-hand informations!
No notification service!
Infos primarily from news media!

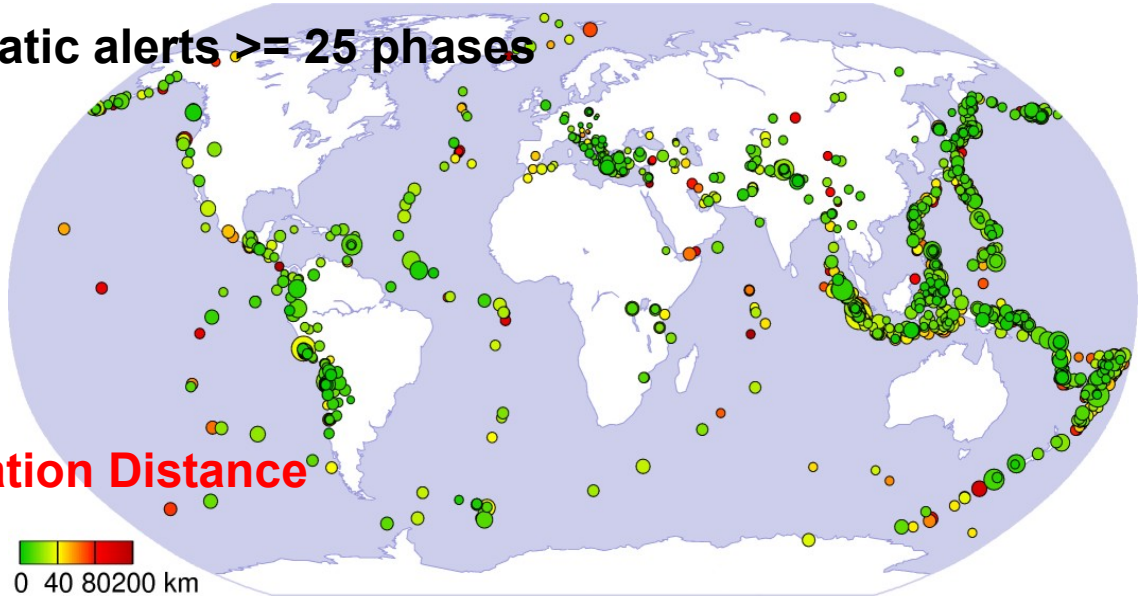
2266 casualties in Algeria - 3 m tsunami on Balearic islands

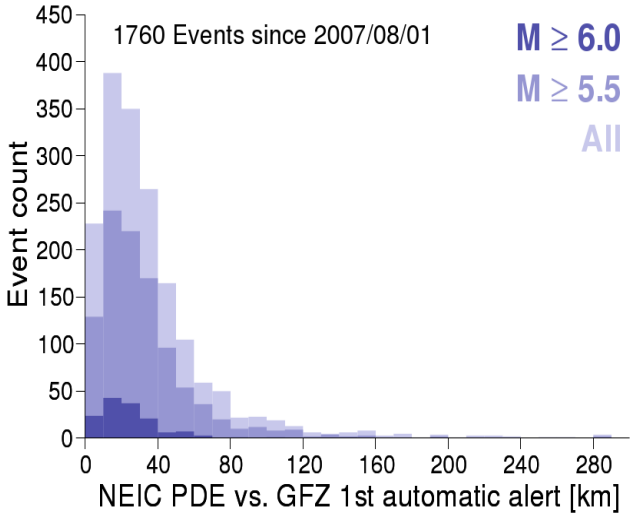
Seismic Data Processing at GEOFON Data Center

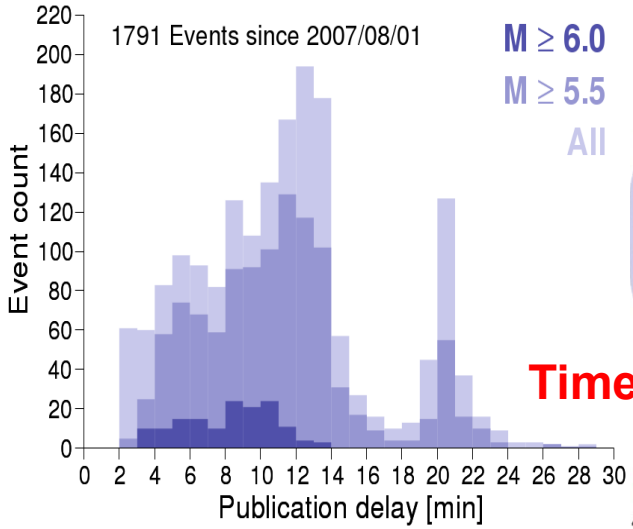


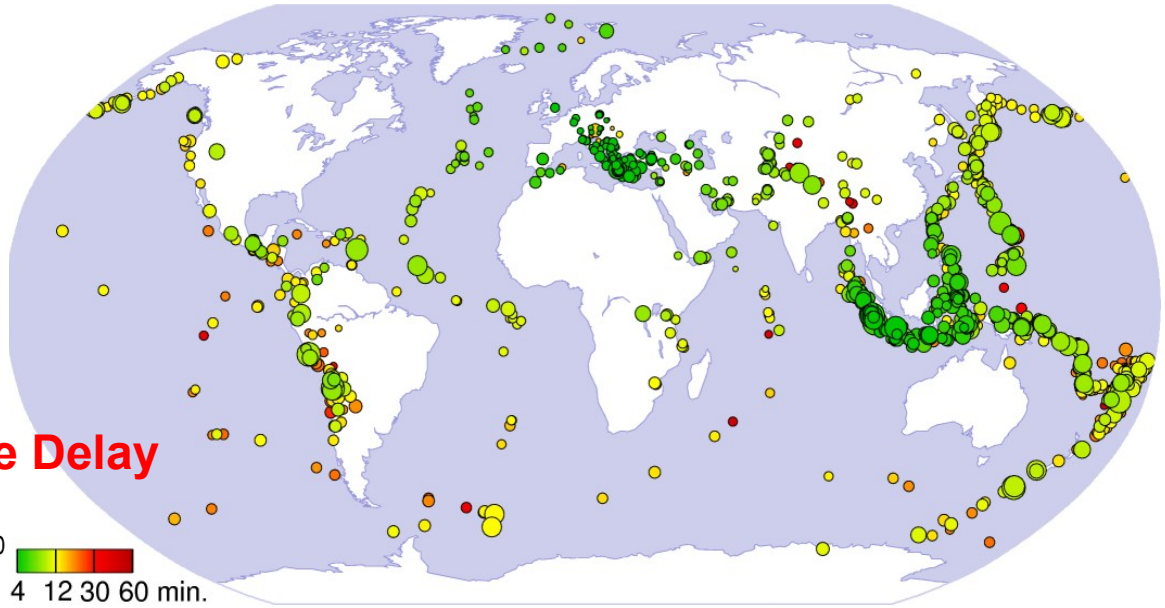
Performance of GEVN Earthquake Monitoring System

Automatic alerts >= 25 phases

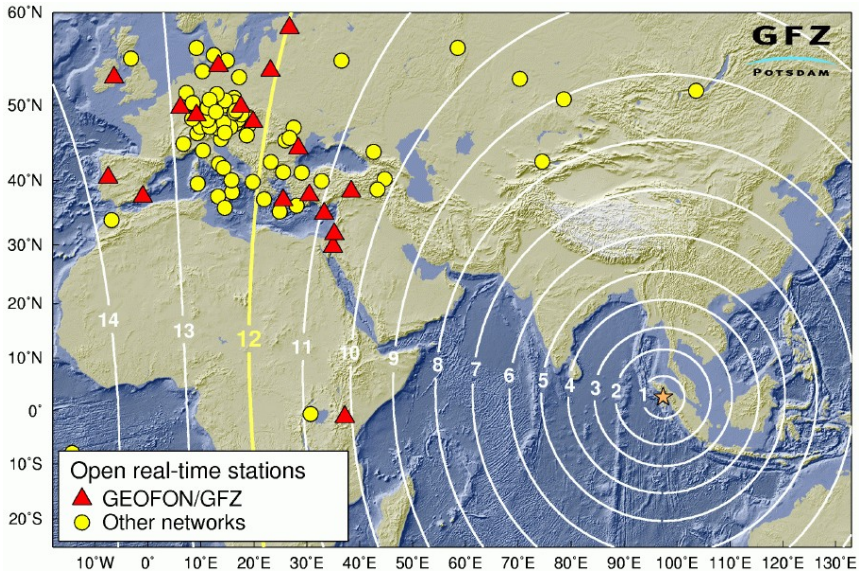


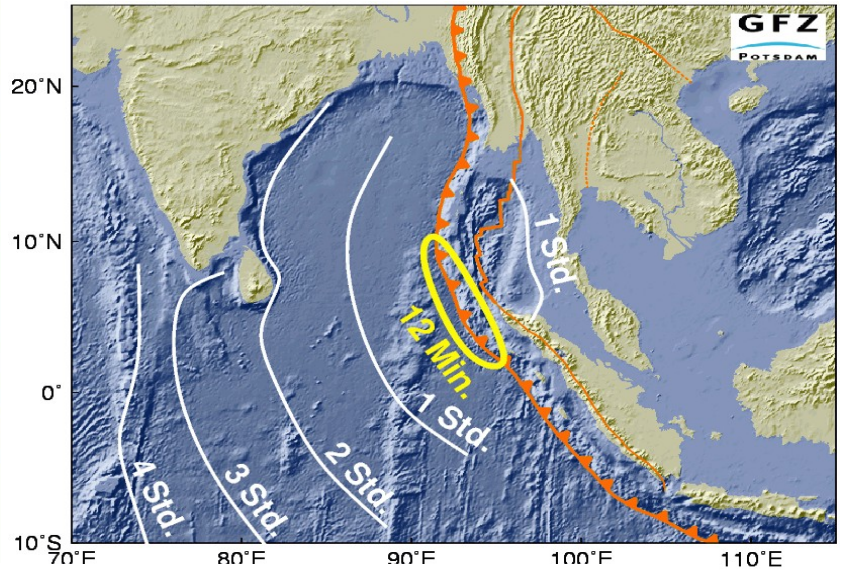


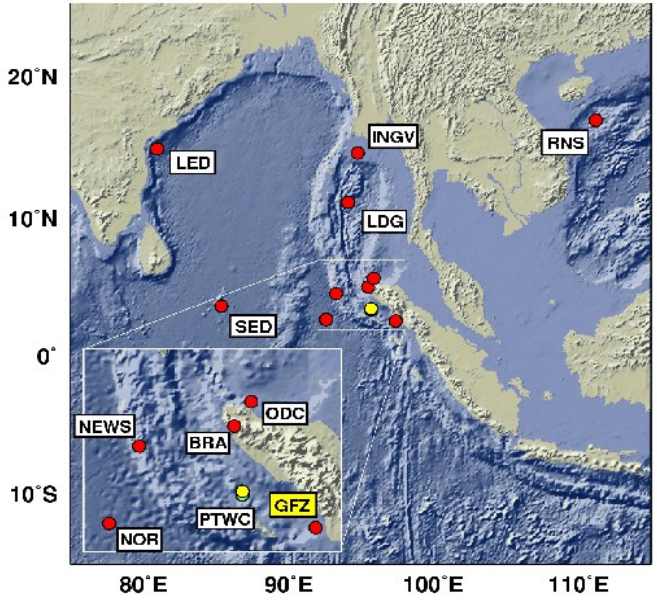




What has GEOFON to do with Tsunami Warning?







EMSC, NEIC
Automatic Location
PTWC

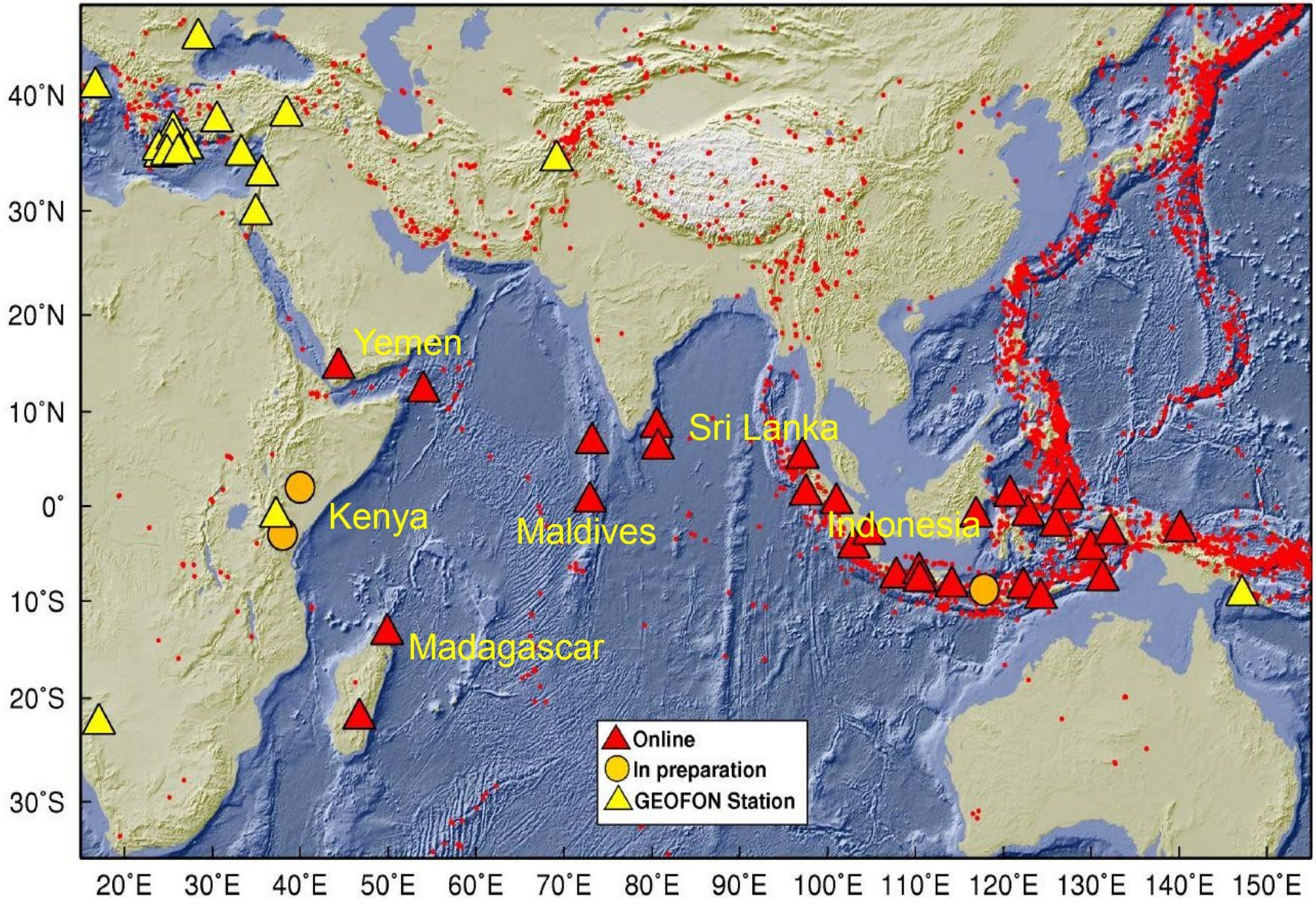
Origin Time:		00:58:50 UTC	Mw=9.0
Germany:	GFZ	01:10:57 +12 min	mb=6.9
Italy:	INGV	+16 min	mb=6.9
Germany:	LED	+18 min	mb=7.1
Switzerland:	SED	+19 min	mb=6.1
Norway:	NEWS	+20 min	mb=5.5
	NOR	+22 min	mb=6.3
France:	RNS	+31 min	mb=6.4
Slovakia:	BRA	+32 min	mb=6.6
Europe/ORFEUS:	ODC	+65 min	mb=7.3
France:	LDG	+731 min	mb=5.9
International Centres (Manual Analysis)			
USA:	NEIC	+79 min	Ms=8.5
Europe/EMSC:	EMSC	+97 min	Mw=8.9
Pacific Tsunami Warning Center			
USA:	PTWC	+15 min	Mw=8.0

=> GITEWS Project

The Great Challenge: Tsunami Warning for Indonesia

Tsunami travel times 20 - 40 min => warning time line < 5 min!

GITEWS Seismic Network for the Indian Ocean



Standard concept for regional and national TWS: the Decision Matrix

Magnitude	Mediterranean		Atlantic	
	Regional 100-400 km	Basin-wide > 400 km	Regional 100-1000 km	Ocean-wide > 1000 km
>7.9	Watch/red Alert	Watch/red Alert	Watch/red Alert	Watch/red Alert
7.5-7.9				Advisory/orange alert
7.0-7.5			Advisory/orange alert	Information/ yellow alert
6.5-7.0		Advisory/orange alert	Information/ yellow alert	
6.0-6.5	Advisory/orange alert	Information/ yellow alert		
5.5-6.0	Information/ yellow alert			

Recent Proposal for NEAMTWS

Confirmation by sea level measurements required!

Tsunami Warning in 5 min – a great challenge!

GITEWS Strategy:

1st step: 5 min warning issued on basis of the most probable pre-calculated tsunami scenario related to the actual seismic parameter set!

Seismic network

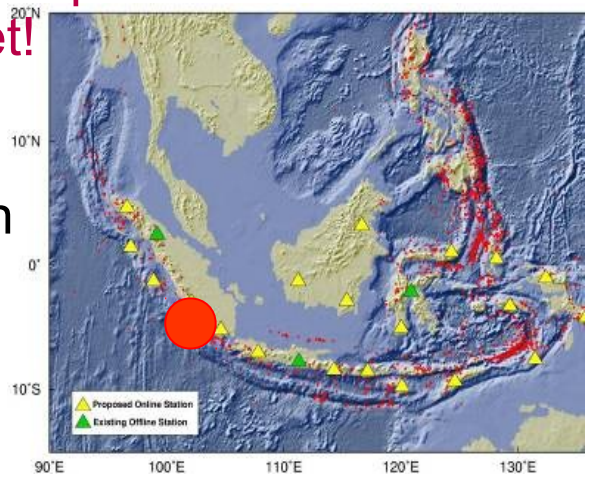
- as many seismic stations as possible close to the trench
- BB, strong motion and CGPS sensors
- private VSAT links

Seismic data processing

- rapid automatic determination of epicenter and depth range of rupture start
- non-saturating magnitudes for regional distances
- determination of rupture direction (if possible)

Pre-calculated tsunami scenarios

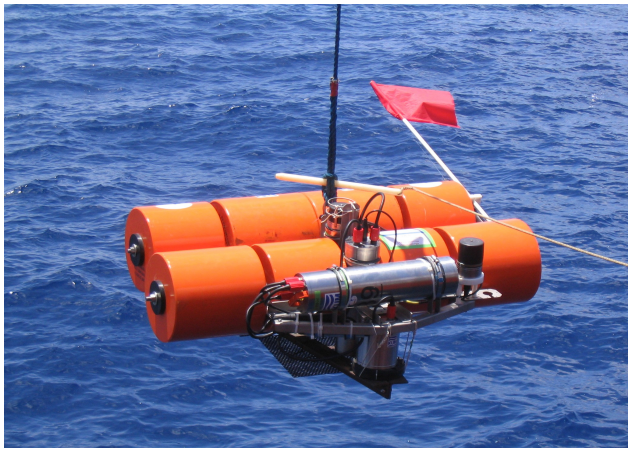
- selection from thousands of pre-calculated tsunami scenarios on basis of continuously updated seismic parameters



The Challenge: Tsunami Warning for Indonesia

2nd step: verification by ocean and coastal sensor systems!

GPS Buoy



Ocean Bottom Unit
(pressure, seismic sensor)

Tide Gauge

3rd step: continuous update of warning status
(new tsunami scenario?)

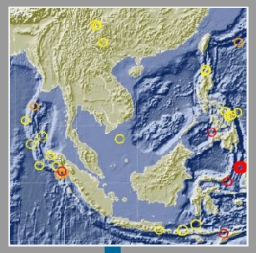
GITEWS Tsunami Warning Concept – a "System of Systems"

GITEWS

GEOFON

Sensor Systems

Earthquake monitoring system



CGPS

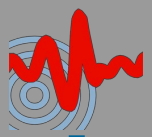
Tide guages

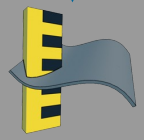
OB pressure sensors

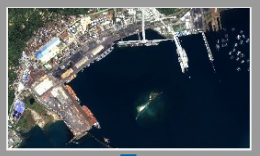
GPS Buoyes

EO Data

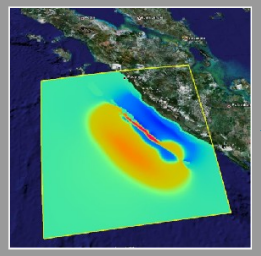
Measurements

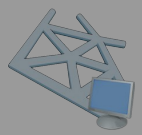


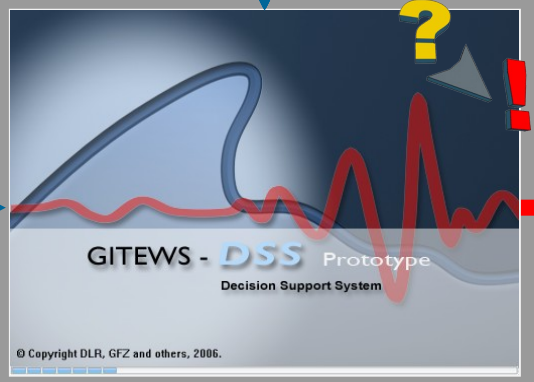




Simulation DB





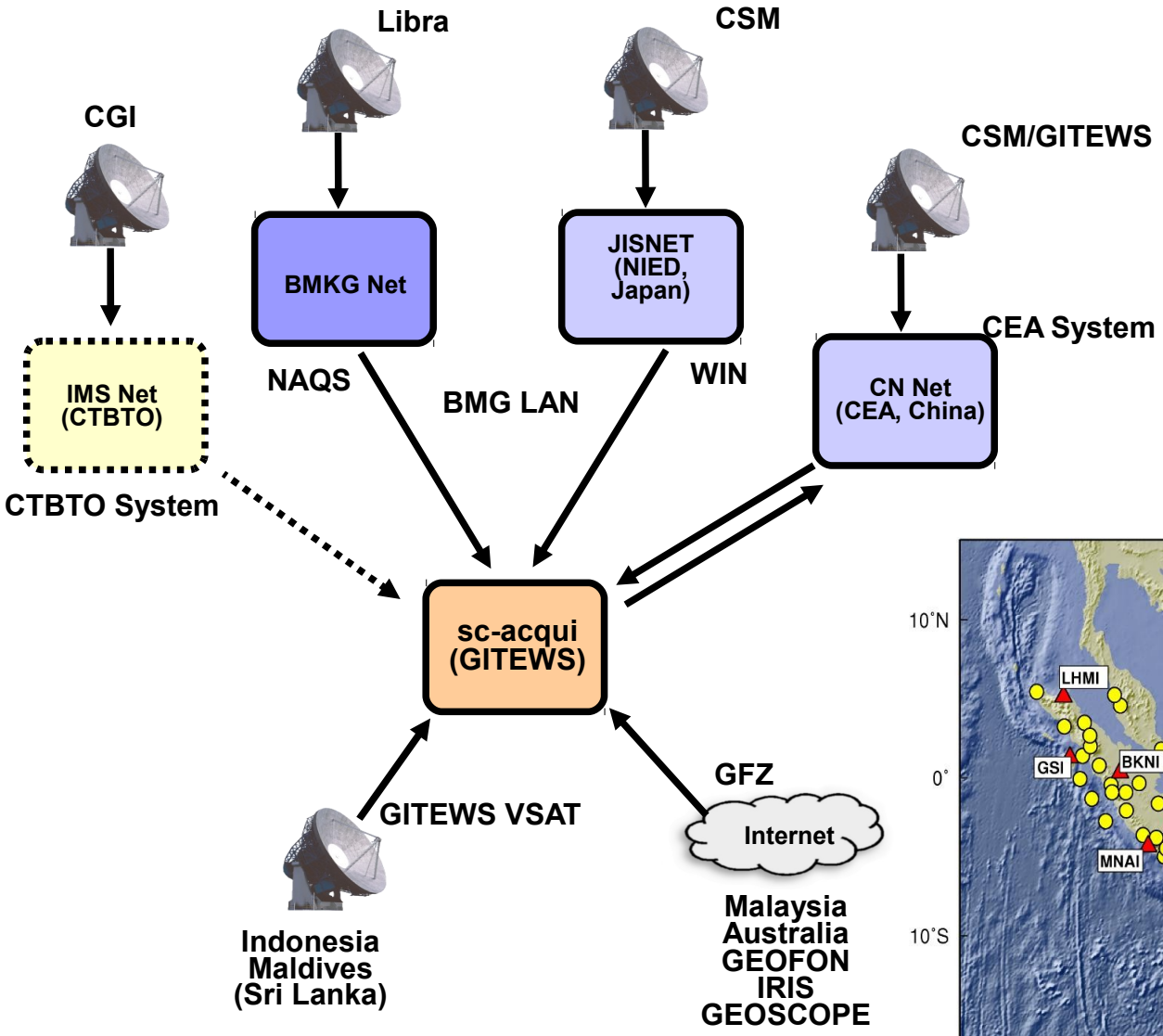


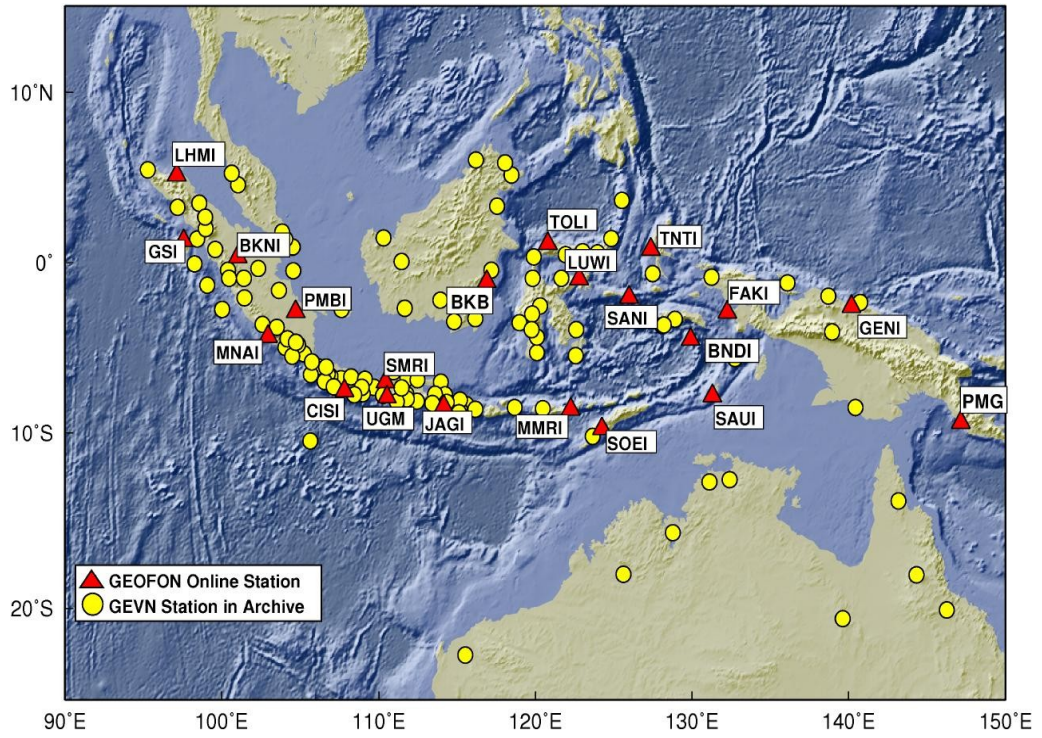
local authorities
exposed population

more national and
international recipients

Situation evaluation and decision support

SeisComP3 at BMKG – Virtual Seismic Network

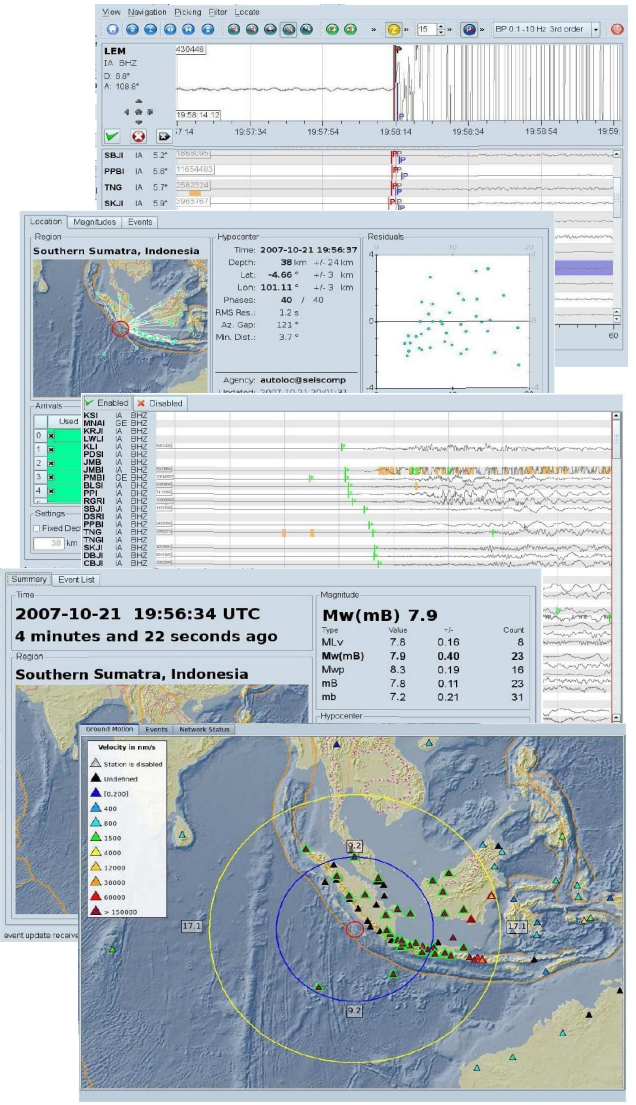




SeisComP3 Software

Present Status:

- Real-time acquisition of virtual seismic networks: (GFZ > 750 stations)
- Visualization of overall situation (earthquake sources and network status)
- Automatic picking of seismic signals
- Automatic pick association and localisation
- Automatic determination of ground velocity
- Automatic determination of different fast magnitudes (Ml, mb, mB, Mw(mB), Mwp, Mj(bmg))
- Manual verification of automatic solutions
- Manual event definition and analysis
- Moment tensors and rupture parameters (under development)



GITEWS

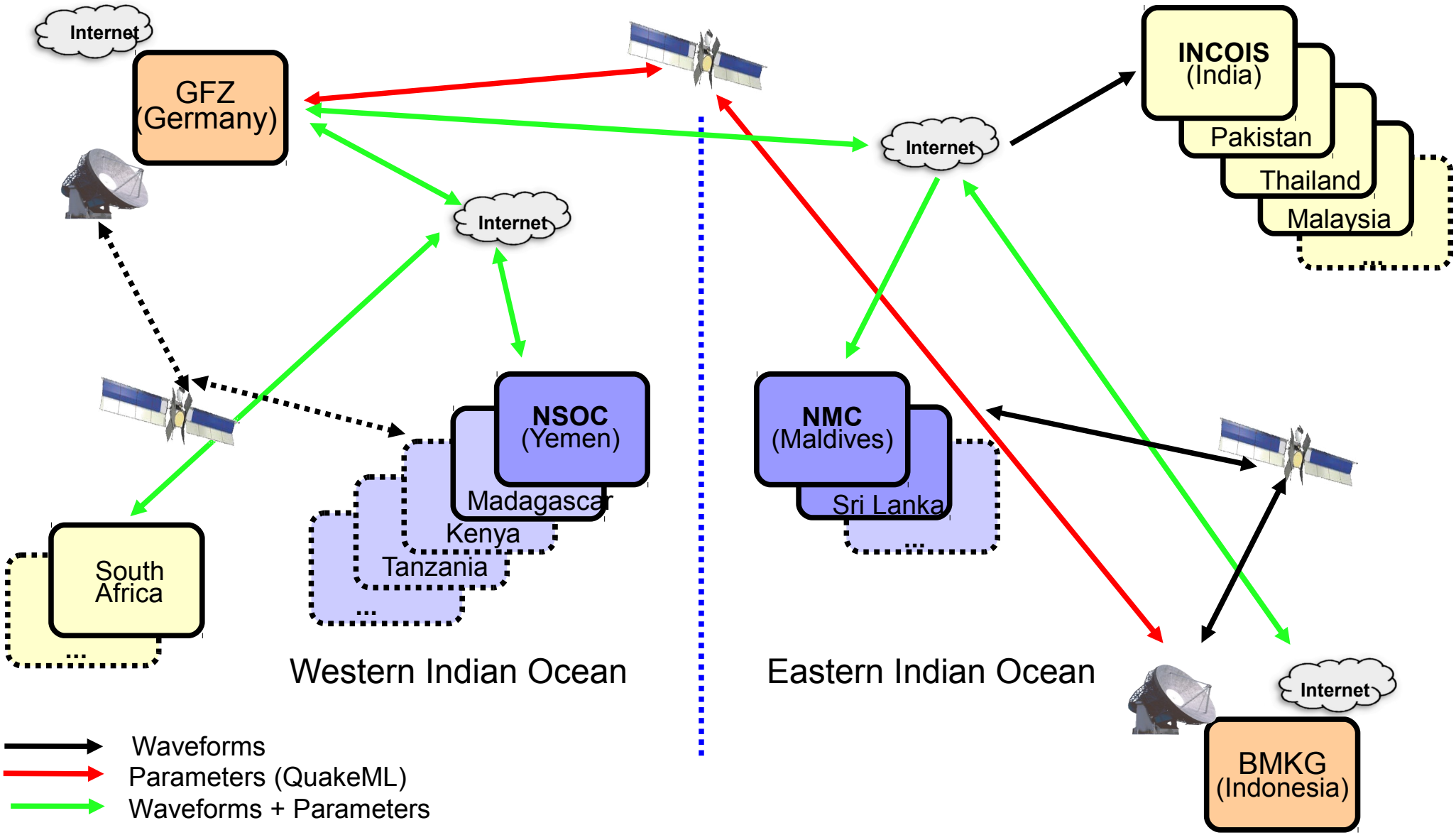
Successful Operation of SeisComP3 at BMKG – Example of the Bengkulu Quake

GFZ Helmholtz-Zentrum Potsdam

September 12, 2007: first successful “home-made” tsunami alarm at BMG **< 5 min !**

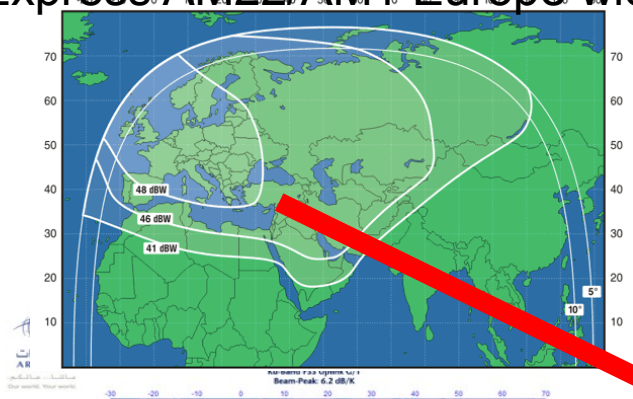
BMG:	M=7.9	4.66S	101.11E	10 km	issued 11:14:42	04:21 min	SC3 man
GFZ:	M=7.9	4.66S	101.13E	10 km	issued 11:16:32	06:10 min	SC3 auto
PTWC:	M=7.9	4.5S	101.3E		issued 11:24	14 min	man
NEIC:	M=7.9	4.369S	101.557E	15 km	issued 11:29	19 min	man
JMA:	M=7.9	4.5S	101.3E		issued 11:36	26 min	man

Distributed SeisComP3 Systems throughout the Indian Ocean – GFZ Background Support

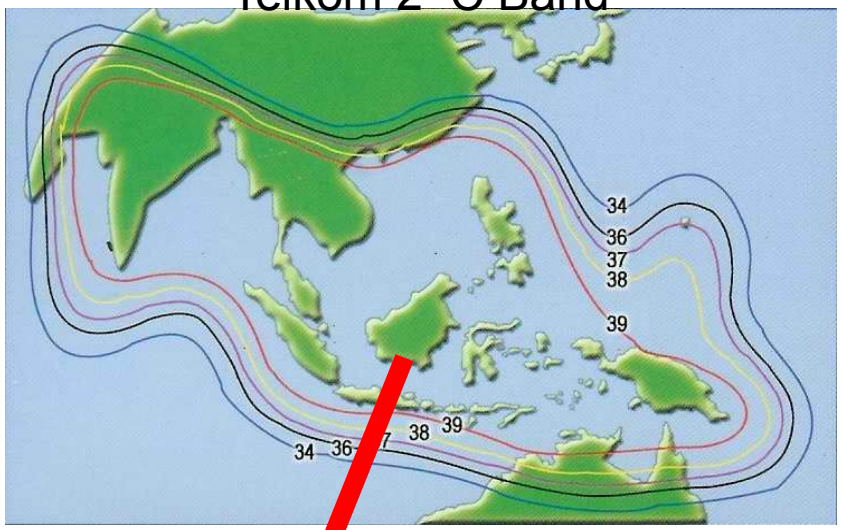


GITEWS/GEOFON VSAT Communication

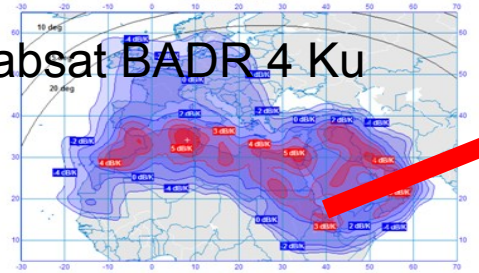
Express AM22/AM1 Europe wide Ku Beam



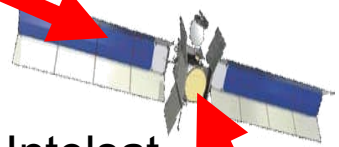
Telkom 2 C Band



Arabsat BADR 4 Ku



CROSAT (Vienna)



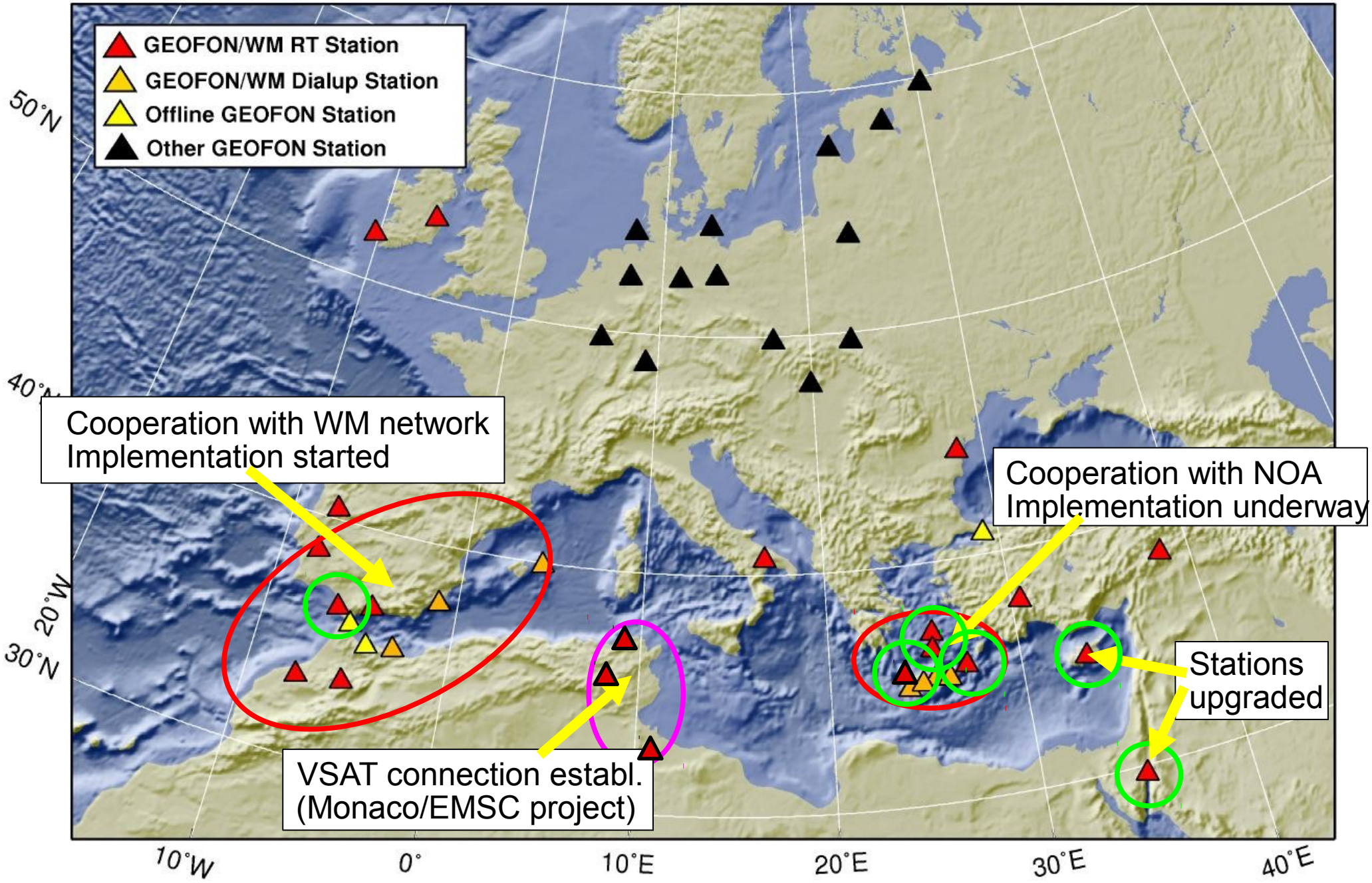
Intelsat

Intelsat IS10 Africa Ku Beam

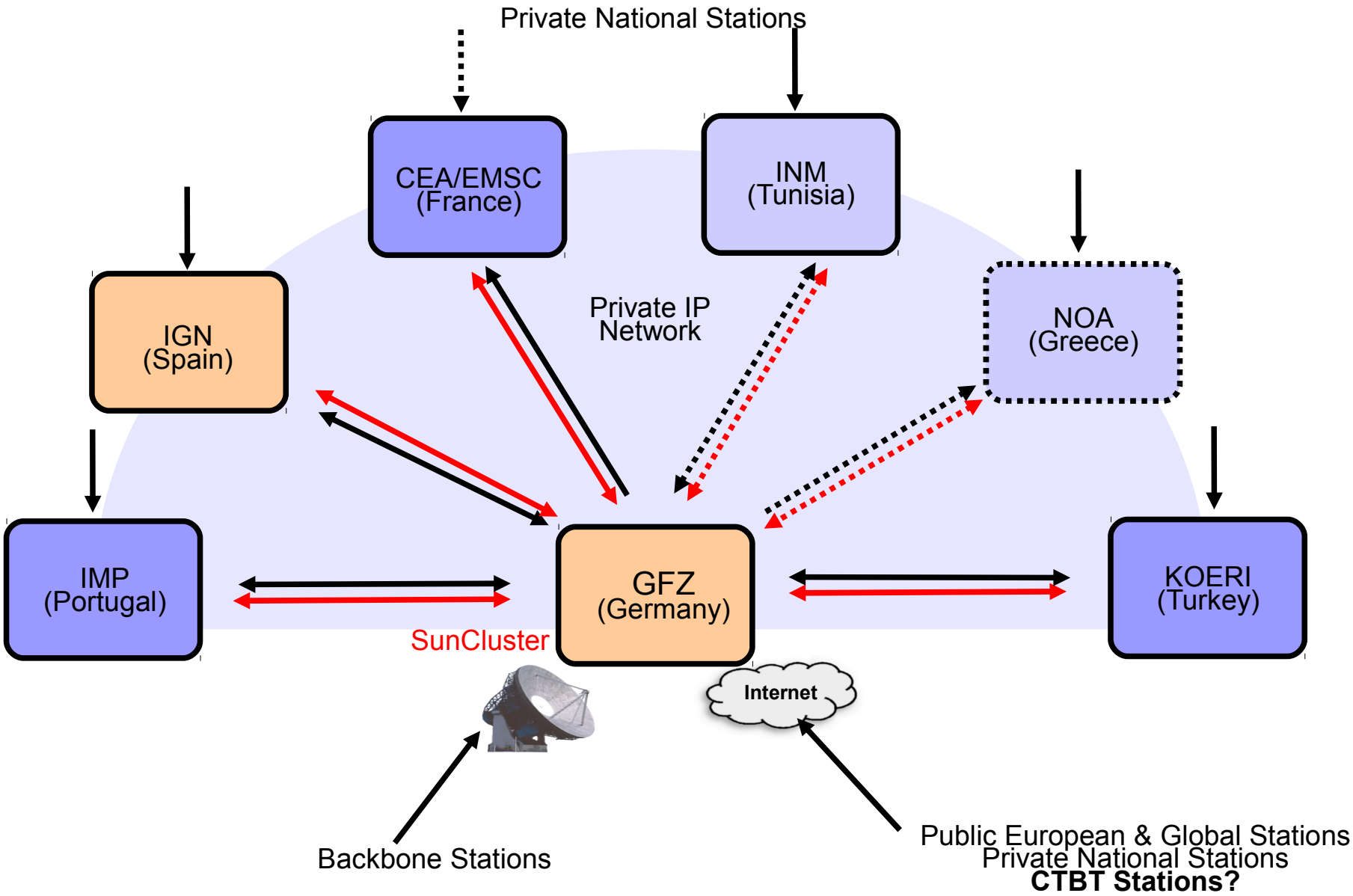
GFZ Helmholtz-Zentrum Potsdam

BMKG

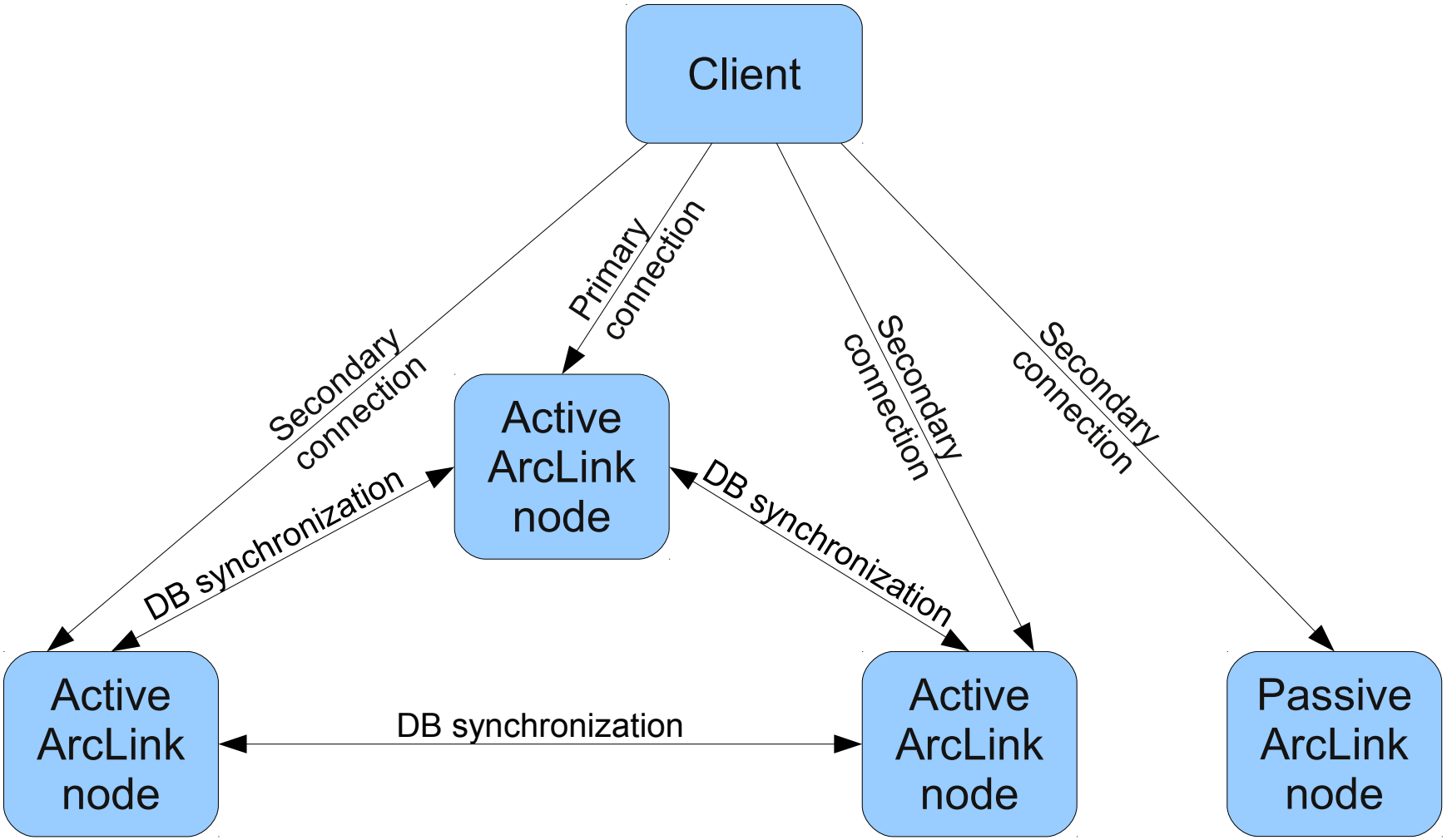
Upgrade of GEOFON Stations in NEAMTWS Area



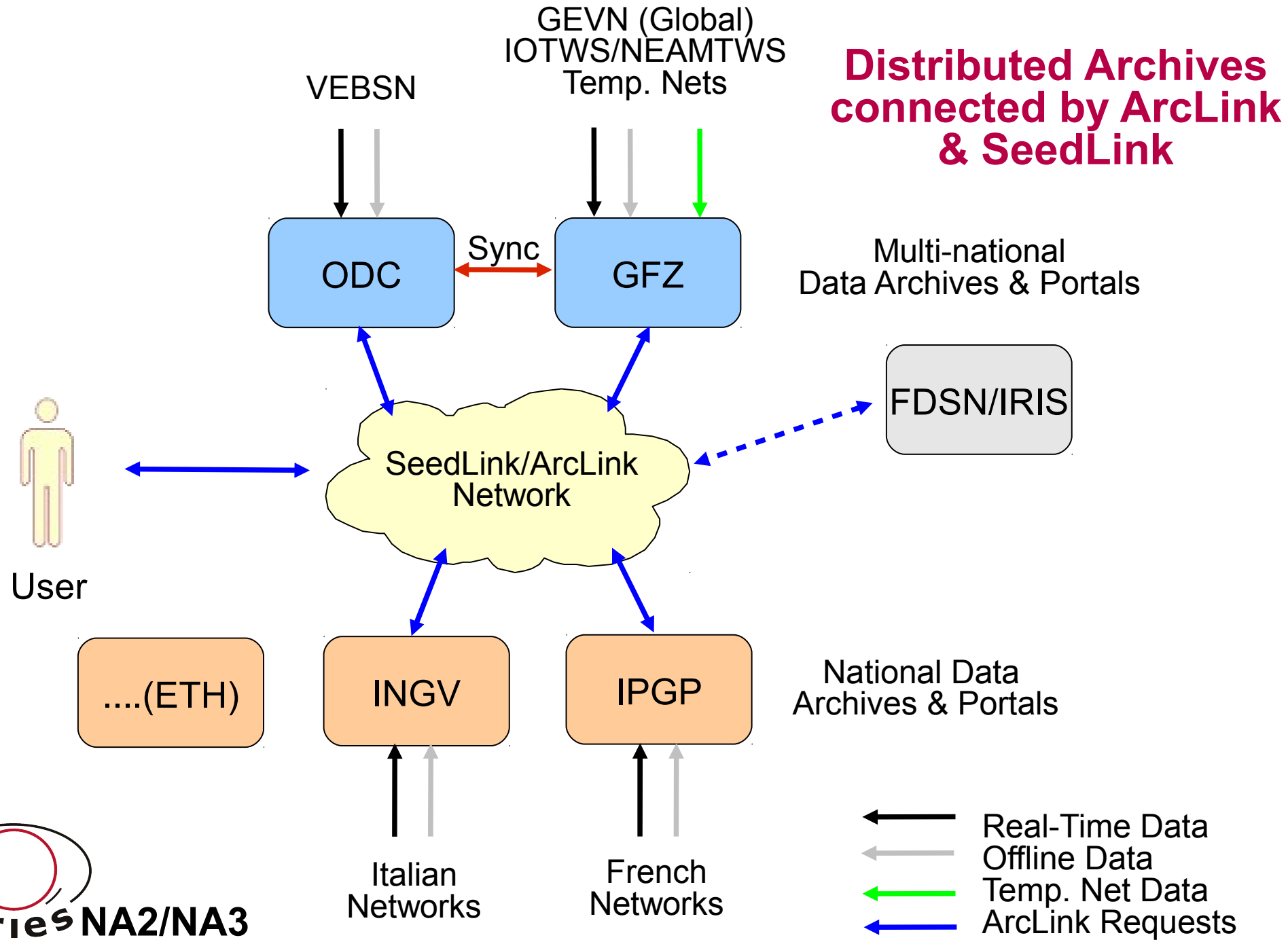
Distributed SeisComP3 System for Interim NEAMTWS



ArcLink Network Concept

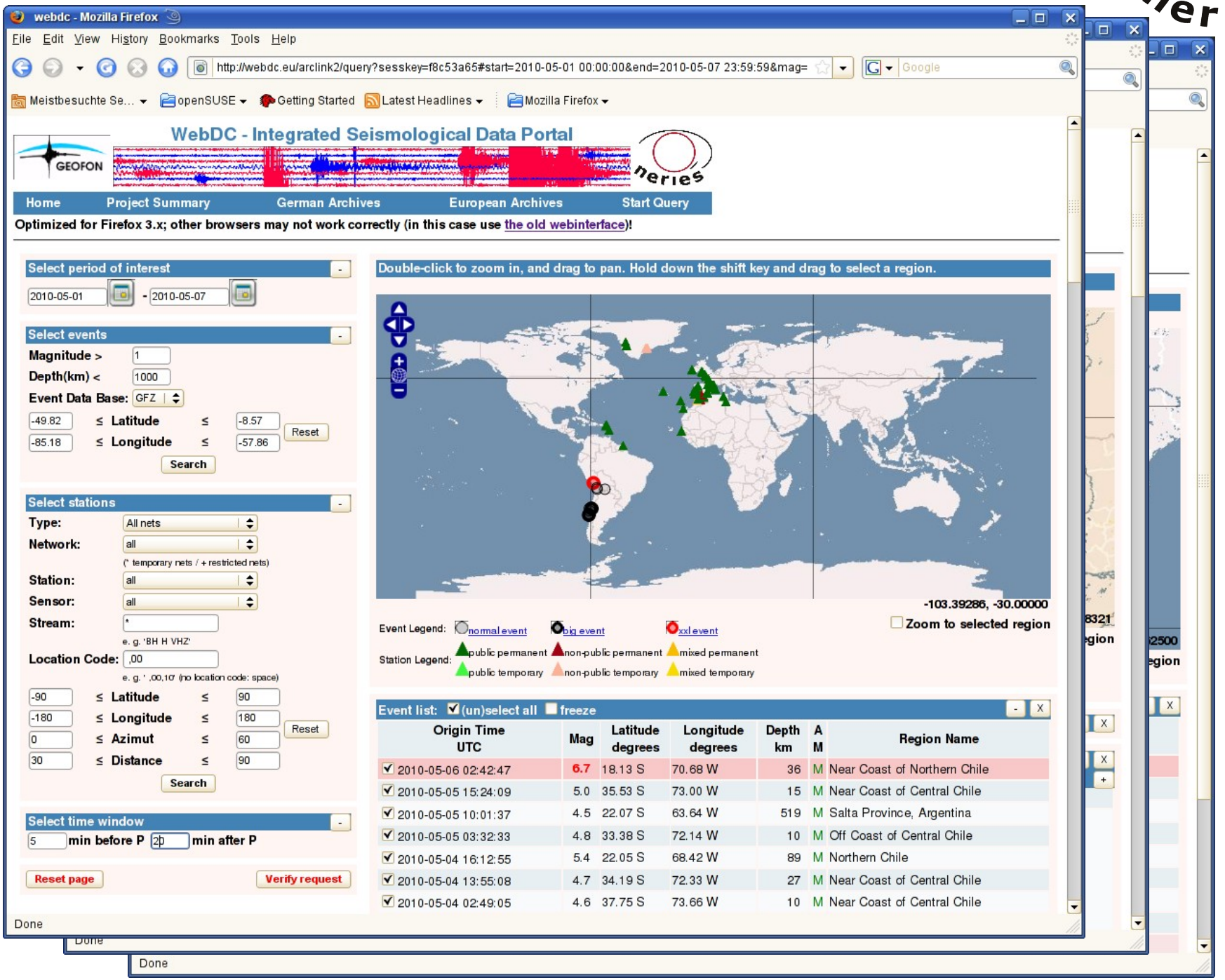


EIDAC – European Integrated Data Center



NERIES NA2/NA3

WebDC.eu Portal – Event+Station+Time Window Selection


webdc - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://webdc.eu/arclink2/query?sesskey=f8c53a65#start=2010-05-01 00:00:00&end=2010-05-07 23:59:59&mag=
Meistbesuchte Se... openSUSE Getting Started Latest Headlines Mozilla Firefox
WebDC - Integrated Seismological Data Portal
GEOFON
Home
Project Summary
German Archives
European Archives
Start Query
Optimized for Firefox 3.x; other browsers may not work correctly (in this case use the old webinterface)!
Select period of interest
2010-05-01 - 2010-05-07
Select events
Magnitude > 1
Depth(km) < 1000
Event Data Base: GFZ
-49.82 ≤ Latitude ≤ -8.57
-85.18 ≤ Longitude ≤ -57.86
Reset
Search
Select stations
Type: All nets
Network: all
(* temporary nets / + restricted nets)
Station: all
Sensor: all
Stream: *
e. g. 'BH H VHZ'
Location Code: ,00
e. g. ' ,00,10' (no location code: space)
-90 ≤ Latitude ≤ 90
-180 ≤ Longitude ≤ 180
0 ≤ Azimut ≤ 60
30 ≤ Distance ≤ 90
Reset
Search
Select time window
5 min before P 20 min after P
Reset page
Verify request
Double-click to zoom in, and drag to pan. Hold down the shift key and drag to select a region.
-103.39286, -30.00000
Zoom to selected region
Event Legend: normal event big event xxl event
Station Legend: public permanent non-public permanent mixed permanent public temporary non-public temporary mixed temporary
Event list: (un)select all freeze
Origin Time UTC | Mag | Latitude degrees | Longitude degrees | Depth km | A M | Region Name
2010-05-06 02:42:47 | 6.7 | 18.13 S | 70.68 W | 36 | M | Near Coast of Northern Chile
2010-05-05 15:24:09 | 5.0 | 35.53 S | 73.00 W | 15 | M | Near Coast of Central Chile
2010-05-05 10:01:37 | 4.5 | 22.07 S | 63.64 W | 519 | M | Salta Province, Argentina
2010-05-05 03:32:33 | 4.8 | 33.38 S | 72.14 W | 10 | M | Off Coast of Central Chile
2010-05-04 16:12:55 | 5.4 | 22.05 S | 68.42 W | 89 | M | Northern Chile
2010-05-04 13:55:08 | 4.7 | 34.19 S | 72.33 W | 27 | M | Near Coast of Central Chile
2010-05-04 02:49:05 | 4.6 | 37.75 S | 73.66 W | 10 | M | Near Coast of Central Chile
Done

GEOFON

NEWS

Thank you very much!

GFZ

Helmholtz-Zentrum
POTSDAM